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XXIV.—*On the Structure and Development of the Antheridium in Ferns.* By Dr. L. Kny*.

[Plate VI.]

The structure of the antheridium of Ferns, notwithstanding its great simplicity, has experienced the most various interpretations.

Nägeli, the discoverer of the organ, describes it† as a gland-like structure, which is frequently apparently unicellular, but generally presents distinctly the form of a sac surrounded by a simple cell-layer, in the interior of which the mother cells of the spiral filaments are produced. It originates from *one* mother cell. After this has projected itself above its neighbours, it first of all divides by a horizontal septum. This first septum is followed in the outer cell by a second, parallel to it. The same process may be repeated once or twice in the successive outer cells. By these divisions a Conferva-like cellular filament of from two to five cells is produced. Each joint becomes broken up into a central cell with four peripheral cells surrounding it. The peripheral cells of all the successive joints form four perpendicular rows, and combine to form a sac-like envelope; the central "spaces" together represent a "canal," in which the mother cells of the spiral filaments are produced. This is closed below by the cell of the prothallium to which it is attached, and above by the four cells of the last joint, which have not completely separated from each other. The apical and basal joints sometimes remain undivided.

When the mother cells of the spiral filaments appear to be

* Translated by W. S. Dallas, F.L.S., from the 'Monatsbericht der Kön. preuss. Akad. der Wiss. zu Berlin,' May 1869, pp. 416–431.

† Zeitschr. für wissenschaftl. Botanik, Bd. i. (1844) p. 168 *et seqq.*, Taf. 4.

enclosed merely by a simple or double membrane, this, according to Nägeli, is always the consequence of the preponderant increase of volume of the contents of the antheridium, and of a compression of the enveloping cells thereby produced. After the evacuation of the spiral filaments, these cells again extend themselves.

Count Leszczyc-Suminski* states that a free cell is produced in the interior of the mother cell of the antheridium as this is arching itself up above its neighbours, and that the contents of this, a homogeneous mucilage, show limpid globules or distinct nuclei furnished with nuclear corpuscles. As soon as this cell has advanced in its growth so far as to fill the walls of the original projection, it shuts itself off from the cells of the prothallium. Frequently a third, flattened cell is formed between the two; this serves as the bearer of the one-celled antheridium. The mother cells of the spiral filaments are produced within this by free cell formation. Count Leszczyc-Suminski, indeed, also figures (Taf. 2. fig. 15) an antheridium with a distinct cellular envelope; but he describes this, in the explanation of his figures, as a morbid state.

Wigand† speaks very decidedly in favour of the unicellularity of the antheridia of ferns, which he investigated in several species, some of which, however, are not exactly defined. According to him, they are frequently produced by the direct metamorphosis of cells of the prothallium, without any previous separation of an anterior elevated portion from the great mass of the cells; but usually the latter occurs. How the mother cells of the spiral filaments originate, whether by division or free cell formation, Wigand leaves undecided.

Schacht‡ never found the antheridia unicellular in the species investigated by him (*Pteris serrulata*, *Asplenium Petrarcæ*, *Adiantum formosum*, and *Aspidium violaceum*); the nucleus was always enveloped by a single layer of limpid cells. In his adhesion to Schleiden's opinion of the general occurrence of free cell formation, he supposes these cells of the wall to be produced as vesicles in the interior of the mother cell. One of them is assumed to become the primitive mother cell of the cells of the spiral filaments, which latter are also produced by free cell formation. At the conclusion of his description, Schacht himself expresses some doubt as to the accuracy of his observations.

* Zur Entwickelungsgeschichte der Farnkräuter (1848), p. 10.

† Botan. Zeitung, 1849, p. 22.

‡ "Beitrag zur Entwickelungsgeschichte der Farnkräuter," Linnæa, 1849, Bd. xxii. p. 758 *et seqq.*

Thuret* conceived the structure of the antheridia quite differently from all previous observers, and, as we shall soon see, was the first to take a correct view of them. In most Polypodiaceæ they consist, according to him, of three superimposed cells—a peduncular cell, which attaches the organ to the prothallium, an annular cell, which encloses the mother cells of the spermatozoids all round, and a terminal opercular cell. In many cases the inner space of the antheridium reaches down to the surface of the prothallium, so that the basal cell also becomes an annular cell. How these annular cells are produced, whether they are formed as such at once, or owe their origin to the coalescence of several cells, is a question which Thuret leaves untouched.

Mercklin†, who, of all the observers hitherto mentioned, had the most abundant material at his disposal, follows Nägeli essentially in the interpretation of his observations, and rejects Thuret's conception (p. 18); whilst Mettenius‡ unconditionally agrees with the latter, and refers only to Thuret with regard to the structure of the antheridium.

According to Hofmeister§, there occurs in the mother cell of the antheridium a division by an inclined partition, either immediately or after one or (rarely) more divisions have taken place in it by transverse septa. The newly formed cell of the second degree divides at once by a radial longitudinal wall. After a single repetition of the division of the apical cell by a septum inclined in an opposite direction, the longitudinal growth of the antheridium ceases. The second cell of the second degree is also divided by a radial septum into two parts, of the form of quadrants of a cylinder. Next one of the cells of the third degree is divided by a septum parallel to the longitudinal axis of the organ, and cutting the side walls at an angle of 45°. The antheridium now forms a semiglobular cellular body, consisting of a four-sided central cell filled with granular plasma, supported by one cylindrical or two semicylindrical cells, enveloped by four cells of the form of segments of a cylinder, and covered by a cell of the form of the segment of a sphere. . . . . The cells of the antheridium which embrace the central one increase no further. The central cell, on the other hand, after considerably increasing in size, in consequence of which the cells surrounding it are flattened

* "Sur les Anthéridies des Fougères," Ann. Sc. Nat. sér. 3. tome xi. (1849) p. 7.

† Beobachtungen an dem Prothallium der Farrnkräuter (1850), p. 12 *et seqq.*

‡ Beiträge zur Botanik (1850), p. 22.

§ Vergleichende Untersuchungen, &c. (1851) p. 79.

into a tabular form, becomes converted by a series of bisections into a globular group of cubical cells.

Henfrey*, who does not appear to have been acquainted with Thuret's work, not only gives a description of the structure of the antheridia agreeing with his throughout, but goes a step further, and endeavours to ascertain the *mode of production of the annular cells*. According to his observations, there is formed in the mother cell of the antheridium, either immediately or only after the separation of a basal cell has taken place, an erect ring-like partition, which makes its appearance simultaneously at all points. The rudimentary antheridium now consists of an inner cylindrical cell and a hollow cylindrical cell enclosing this. A horizontal septum applies itself to the upper part of the annular partition; and by this the opercular cell, which is convex above, is separated from the central cell. If the latter (or the products of its division) be subsequently enclosed by *two* annular cells, these, according to Henfrey, are always produced by the division of the first formed annular cell by means of a septum running round horizontally.

It will appear from what follows that my observations do not confirm the developmental history given by Henfrey.

Wigand, in a second memoir†, in continuation of his previous communication, gives comparative observations upon the structure of the antheridium in many species of ferns. For a certain number of cases he maintains his previous opinion of the unicellularity of the entire organ. In most species he admits the existence of a proper antheridial wall, which embraces the mother cells of the spermatozoids either on all sides or only in part. The closed rings, the presence of which did not escape him, are described by him as "circles of peripheral cells." The number of cells united to form a circle is, according to him, usually four, sometimes five or six (*l. c.* p. 46).

Hofmeister‡ affirms, in opposition to Henfrey, that he had repeatedly convinced himself of the correctness of his previous statements upon the developmental history. Hollow cylindrical cells are certainly recognizable in nearly mature and in emptied antheridia; but these, he says, are produced by the lateral fusion of several cells by the absorption of their transverse partitions.

* "On the Development of Ferns from their Spores," Trans. Linn. Soc. vol. xxi. p. 121.

† "Weitere Beobachtungen über die Keimungsgeschichte der Farrn," Botan. Untersuch. 1854, p. 44 *et seqq.*

‡ Beiträge zur Kenntniss der Gefässkryptogamen, ii. p. 604, note.

The last explanation of the development of the fern-antheridium which Hofmeister gives, in the English edition of his 'Vergleichende Untersuchungen'*, does not differ essentially from his former one. He says, "The analogy to be derived from the process of development of the antheridia of the Muscineæ renders it probable that the large central cell is formed by the production of an excentrical, inclined, longitudinal septum in the young antheridium, followed by the production of another excentrical septum cutting the latter at right angles, and the subsequent formation of a longitudinal septum cutting both the above at an angle of 45°, such formation taking place after the apical cell of the antheridium has been isolated by a strongly inclined, almost horizontal septum cutting the primary longitudinal septum. When the central cell is surrounded by two zones of enveloping cells, it is manifest that the two zones originate in the transverse division of the primary single zone."

Lastly, Strassburger† has occupied himself with the present subject. In *Pteris serrulata*, according to him, the mother cell of the antheridium is divided first of all by two oppositely inclined septa, which are set obliquely upon the bottom of the antheridium and cut its side walls nearly at their summit. "These first two septa are soon followed respectively by two other opposite ones, cutting them at an angle of 45°. All these four septa are strongly inclined together towards the base of the antheridium, without, however, absolutely meeting there; and in this way a central quadrangular space is cut off, which is widened above in a funnel-like form. The upper part of the antheridium is still unicellular; but a number of divisions soon occur in it. First of all, four upper lateral cells are produced in exactly the same way as the inferior ones; they are set upon these inferior ones, and inclined together towards the apex of the antheridium. Finally, between these upper lateral cells an opercular cell, of the form of the segment of a sphere, is separated from the vertex of the antheridium. In this way a cellular body is formed, consisting of a central cell, eight lateral cells, and an opercular cell. The central cell, seen from above, is quadrangular, bellied out in the middle of its height, gradually diminished towards its extremities, especially the lower one, and it becomes the primitive mother cell of the spermatozoids. It contains an abundance of protoplasm and a distinct cell-nucleus, whilst the lateral cells as yet contain only a few chlorophyll-grains."

* On the Germination, Development, and Fructification of the higher Cryptogamia (London, 1862), p. 186.

† "Die Befruchtung bei den Farrnkräutern," Mém. de l'Acad. de St. Pétersb. 1868, p. 2.

My own investigations as yet relate only to a few species. Nevertheless, to judge from the statements and pictorial representations contained in the literature of the subject, the most important differences in the structure of the antheridium are represented by them. In a short time I hope to be able to complete my observations upon most of the genera of Filices. It scarcely needs to be mentioned that I have not obtained the materials for my investigation from the impure cultivated forms of the fern-houses, but that the sowings have been made specially for my purposes, and carefully protected from foreign interlopers.

Aneimia hirta possesses antheridia which are remarkable for their considerable size and simple structure. In the mature state (Pl. VI. fig. 5) they consist of a depressed cylindrical stalk cell, a comparatively elevated annular cell set upon this, in which no indication of a longitudinal septum is visible, and a low opercular cell in the form of the segment of a sphere. The inner cavity enclosed by the three cells is filled by the special mother cells of the spermatozoids.

On weakly prothallia growing very close together they spring in about equal abundance from the underside of the leafy surface and from the margin. In the last-mentioned position their development is easily ascertained by the comparison of different stages.

The youngest observed rudiments, which scarcely projected as hemispheres above the margin (fig. 1), and in the fresh state appeared to be uniformly filled with turbid protoplasm, proved, on closer examination, to be not only separated from the marginal cell by a septum, but even already to consist of three cells. The lower, peduncular cell, which is greatly curved inwards, is bounded by two parallel walls, of which the superior is the youngest. Upon this follows a watch-glass-shaped septum curved outwards in a circle concentric with the peripheral boundary of the peduncular cell, cutting off an inner cell of the form of a biconvex lens from a shallow bell-shaped cell which covers it. Whilst the peduncular cell scarcely becomes perceptibly elongated, the two other cells both become strongly arched outwards. At the same time the septum separating them long remains very delicate, so that it eludes direct observation (fig. 2 *a*); when the prothallium is treated with solution of potash and muriatic acid, it makes its appearance quite distinctly (fig. 2 *b*). About the time when the inner cell has acquired a hemispherical form, there is produced in the bell-shaped cell covering it a funnel-shaped septum widening upwards, which is applied both to the inner and outer wall, in a closed circle. Its formation appears to be

perfectly simultaneous. By it the opercular cell is separated from the hollow cylindrical enveloping cell (ring cell).

In each of the four cells of which the antheridium is composed in this state of development, a nucleus is distinctly recognizable. In the opercular cell it is applied to the lower septum, and is surrounded by numerous chlorophyll-grains; in the ring cell it clings to the inner wall on one side; in the central cell it occupies exactly a middle position, and, on account of the abundance of chlorophyll and protoplasm, appears only as a lighter spot.

The central and ring cells grow predominantly in length and less in circumference. At the same time the inclination of the septum which separates the latter from the opercular cell becomes somewhat less. Whilst all the other cells remain undivided, the central cell is broken up, by a number of successive divisions, into the special mother cells of the spermatozoids. The position of the septa with regard to the longitudinal axis of the organ and to each other is now rather irregular, as may be seen from figs. 3 & 4.

The cells of the last generation round themselves off from each other, in the manner characteristic of the special mother cells, until they become completely isolated. Within the delicate cellulose membrane there is first a layer of hyaline protoplasm; towards the middle numerous granules are imbedded in the plasma. The evacuation of the special mother cells always takes place through an irregular rupture of the opercular cell. The torn fragments of the membrane of this shrink together, and soon become unrecognizable. The gradual appearance of the cellular contents is accompanied by a considerable extension of the basal cell and ring cell (Pl. VI. fig. 6). This renders it probable that the opening of the antheridium is effected chiefly by the turgescence of these two cells. In the membrane of the ring-cell, which at the same time becomes much shortened, folds are formed in larger or smaller number, which, when seen from above, do not usually extend beyond half the thickness of the ring (fig. 7), but in a side view sometimes present a deceptive resemblance to true septa. I suppose that these have played a great part in the erroneous representations of the structure and development of the antheridium of ferns. That the ring cell is not, as supposed by several of the observers above mentioned, produced by the amalgamation of four or more originally separate peripheral cells, but is a ring cell from its first foundation, is perfectly evident from the constant presence of only *one* nucleus. Even after evacuation has taken place, this remains for some time distinctly recognizable (fig. 6).

The antheridia of *Ceratopteris thalictroides* (figs. 8–10) are at the first glance very dissimilar to those of *Aneimia*. On closer examination, it appears that the difference lies more in the dimensions of the individual parts than in any divergence of structure. Most of the antheridia here originate from marginal cells of the prothallium; only a few are developed upon the lower surface of the frond. In the former, the only one which I have closely traced, the divisions of the mother cell are completed at a period when it scarcely projects perceptibly above its neighbours.

The first septum is usually unsymmetrical and strongly curved. It is attached on the one side to the free outer wall of the mother cell, and on the other to one of the side walls which separate this from the neighbouring cells. The lower cell thus cut off of course extends only on one side to the free margin of the prothallium (figs. 9 *a*, 10). Unfortunately I have no direct observation of the next step in division. From the mature state, in conjunction with the undoubtedly ascertained process of development in *Aneimia hirta*, I think I may conclude that here also the first-formed wall is followed by a watchglass-shaped membrane, which separates an inner cell of the form of a biconvex lens from an outer shallow bell-shaped cell. In the latter, as in *Aneimia*, a funnel-shaped septum widening upwards would then be produced, isolating the opercular cell from the ring cell. The latter here always remains short and at the same time slightly curved downwards. This, combined with the want of a true peduncular cell, is what chiefly causes the peculiar habit of the antheridium of *Ceratopteris*.

Divergences from the structure just described but seldom occur. The commonest is, that the first septum attaches itself symmetrically to the two lateral walls (fig. 9 *b*) instead of only to one of them. Only in the rarest cases have I observed mature antheridia in which the separation of the ring cell and the opercular cell had been omitted, and in which, therefore, the special mother cells were enclosed in a lenticular space between two cells.

Asplenium alatum possesses antheridia in which the nucleus is usually enclosed by *two superimposed* ring cells (Pl. VI. figs. 14 & 15). The operculum, as in *Aneimia hirta* and *Ceratopteris thalictroides*, is unicellular. A peduncular cell is not always present (figs. 11, 14, & 15).

On the weakly prothallia examined by me (which had been much crowded during growth) the antheridia were developed chiefly on the surface of the frond, frequently in such abundance that every cell bore an antheridium. They were pro-

duced less numerously on the marginal cells. Their development could be best traced on filiform adventitious shoots, of which each ramification, often, terminated with an antheridium (fig. 13).

The youngest rudiments observed by me were hemispherical. The first septum that makes its appearance in them has the form of a funnel; it attaches itself to the flat basal surface, in a narrow circle concentric with the peripheral boundary of the latter, and widens upwards so as to strike (also in a closed circle) about the middle of the spherically arched outer wall (figs. 11, 12). The lower (and at the same time the outer) of the two sister cells, which, even at its formation, possesses the form of a ring widened at the base and narrowed to an edge above, retains this essentially; it is afterwards incapable of any further division. The other sister cell, which is conically narrowed at its lower end, distinctly exhibits a cell-nucleus in this lower part. Its increase in length takes place exclusively in its upper, free half. If a young antheridium in this stage of development, when the upper part begins to distinguish itself slightly, even in external contour, from the first annular enveloping cell (fig. 13 *a*), be treated with diluted solution of caustic potash, and, after being once washed, with muriatic acid, we observe a delicate divisional line, to which a cell-nucleus is applied both above and below (fig. 13 *b*). This septum, which separates a superior shallow bell-shaped cell from the central cell (the primitive mother cell of the spermatozoids), applies itself on all sides to the upper margin of the first-produced funnel-shaped cell-wall, and is slightly curved upwards in the form of a meniscus.

Simultaneously with the further longitudinal growth of the young antheridium, a stronger arching of this septum takes place. After it has become about parallel to the free outer wall, an annular wall, becoming slightly widened upwards in a funnel-shape, attaches itself almost at right angles to the upper surface at an equal distance from the vertex all round (fig. 14).

By this means the bell-shaped cell is divided into an inferior ring cell and a superior opercular cell, the latter presenting the form of a truncated cone with its spherical basal surface turned upwards. With this the development of the antheridial envelope, in the great majority of cases, is concluded. Both the ring cells, as well as the opercular cell, show a nucleus, which is distinctly recognizable upon careful examination. Even after the evacuation of the antheridium, this is still retained for some time in the ring cells (fig. 17).

It is only after the foundation of the antheridial envelope

that a series of divisions takes place in the central cell, leading to the formation of the special mother cells. The first septa are usually directed exactly in accordance with the longitudinal axis of the antheridium, and placed at right angles to each other in three directions; afterwards radial walls alternate several times with tangential ones. The cells of the last grade, the number of which is not constant, become rounded off from each other. Their very delicate membrane is followed, immediately within, by a hyaline plasma-zone; the central part of the contents is distinctly granular.

The opening of the antheridium is here also evidently effected by the turgescence of the two ring cells. After the opercular cell is irregularly ruptured, and the special mother cells are evacuated, these extend themselves inwards, at the same time becoming slightly shortened. By this means are formed radially perpendicular folds, which, when looked at laterally, often present a delusive resemblance to true septa in appearance*. Here also, as in *Aneimia hirta*, we may easily convince ourselves, by examination from above, that they do not attain the outer membrane.

Exceptionally we sometimes observe antheridia with only *one* ring cell. This has then, so far as the mature state enables us to judge, exactly the same origin as the *upper* ring cell in normal antheridia: it is the sister cell of the opercular cell.

Rather more frequently antheridia with *three* ring cells are observed. The middle one, in this case, is probably formed by a funnel-shaped septum in the same way as the lower one. This was certainly the case in two abnormal antheridia, in which the second ring cell had attached itself laterally and obliquely to the lower one (fig. 16).

Cibotium Schidei directly approaches *Asplenium alatum*, but shows some remarkable peculiarities. The lowest of the two ring cells, which are here present in the great majority of the antheridia, usually rests upon a basal cell which is only developed on one side, and is then lower upon one side than on the other, whilst the upper ring cell is more regularly developed (fig. 19). The opercular cell does not remain undivided, but is divided into two daughter cells of unequal size by a wall, which is perpendicular to the outer wall, but strongly convex towards the middle point of the cell. The larger cell is crescentiform, the smaller one elliptical, pointed at both

* In two cases I believe I positively ascertained the presence of a single true longitudinal wall in one of the ring cells. I regard them as supplementary structures. As to the mode of their production, I can, unfortunately, say nothing further.

ends (fig. 18). In the smaller of the two sister cells a further division sometimes takes place. It is either divided into two equal parts by a wall perpendicular to the last-formed one, or an oppositely curved wall attaches itself on both sides to the first wall. The operculum is then composed of a central and two peripheral cells. Rarely the second wall of the operculum is parallel to that first formed.

At the opening of the antheridium the operculum is not irregularly ruptured as in *Aneimia hirta*, *Ceratopteris thalictroides*, and *Asplenium alatum*, but the smaller cell, or, when it consists of three, one of the two smaller cells, is separated from its union with the neighbouring cells, and thrown back like a valve.

The structure of the ring cells, so far as I could observe, is perfectly analogous to that described in *Asplenium alatum*; here also the lower one is essentially different in its origin from the upper one. The lower one is cut off directly by a funnel-shaped septum from the primitive mother cell of the antheridium, whilst the upper one, with the operculum (which is afterwards pluricellular), is the product of division of a bell-shaped cell.

The process of development of the antheridia of *Osmunda regalis* differs completely from the examples above described. Closed ring cells never occur in it. The mother cell is first of all divided by an oblique wall, which is slightly concave inwards and is followed in the upper and larger of the two sister cells by a second wall inclined in the opposite direction; only in rare cases three successive walls are formed, and these then diverge at angles of 120°. Whilst the peripheral cells undergo no further division, in the inner and at the same time superior cell a septum, nearly perpendicular to the longitudinal axis of the antheridium and slightly concave below, is formed, and attaches itself to the first-formed septa on all sides. The central cell is then broken up by a series of divisions, in which no definite rule can be recognized, into the special mother cells of the spermatozoids; the opercular cell is divided at the same time, by several walls running in the same direction across its vertex, into three or four cells, the outer contour of which usually becomes waved by subsequent extension. They form the greater part of the wall of the antheridium*.

The interest attaching to the facts above communicated goes far beyond the developmental history of the Ferns. As far as I know, cells in the form of closed rings have only been observed in the mature fronds of some species of *Aneimia*,

* I shall give a more detailed account of the antheridia of *Osmunda* in a memoir which will shortly appear in Pringsheim's 'Jahrbuch.'

where they surround the pair of closing cells of the stomata. With regard to the mode of their formation, there is a still unsettled difference of opinion between Hildebrand* and Strassburger†; but both of them agree in thinking that the ring cells are not formed as such, but only acquire their peculiar form subsequently. The antheridia of the Polypodiaceæ and Schizæaceæ consequently present the first example of a *direct production of ring cells by the formation of funnel-shaped septa*; they show at the same time that this process, which has hitherto been quite isolated in the vegetable kingdom, admits of two modifications—the ring cells being in one case cut off from a *hemispherical*, and in the other from a *bell-shaped* mother cell. It is to be hoped that I may succeed, in other species better suited for the investigation than those hitherto examined by me, in tracing more accurately the process of septum-formation and the behaviour of the cell-nucleus during that process. Only then will it be possible to decide whether this new form of cell-formation ranges itself immediately beside that previously observed, or whether it is essentially different therefrom.

EXPLANATION OF PLATE VI.

Fig. 1. Youngest observed developmental stage of a marginal antheridium of *Aneimia hirta*. The central cell possesses the form of a biconvex lens. (Drawn after treatment with caustic potash and muriatic acid.)

Fig. 2. A somewhat older state; the bell-shaped cell is still undivided: *a*, fresh; *b*, after the same treatment as fig. 1.

Fig. 3. Half-grown antheridium; the envelope is completely formed; in the central cell the first divisions are already produced: *a* & *b* as under fig. 2.

Fig. 4. A somewhat older state than fig. 3: *a* & *b* as under fig. 2.

Fig. 5. Mature antheridium. (It was evacuated during observation.)

Fig. 6. An antheridium just evacuated. (To the right the cell-nucleus of the ring cell is distinctly recognizable.)

Fig. 7. An antheridium which has long been evacuated, seen from above. The inner folded wall of the ring cell is already strongly embrowned; the cell-nucleus is no longer recognizable.

Fig. 8. Half-developed antheridium of *Ceratopteris thalictroides*, springing obliquely from a marginal cell of the prothallium. The envelope is completely formed; the central cell is divided crosswise into four cells. (Drawn after treatment with caustic potash and muriatic acid.)

Fig. 9. Two mature antheridia of the same species: *a*, with normal, unsymmetrical, *b*, with abnormal, symmetrical basal cell.

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* "Ueber die Entwickelung der Farrnkrautspaltöffnungen," Bot. Zeit. 1866, p. 245.

† "Ein Beitrag zur Entwickelungsgeschichte der Spaltöffnungen," Pringsheim's Jahrb. v. p. 309.

Fig. 10. Evacuated antheridium of the same species. A special mother cell has remained behind in the inner space.

Fig. 11. Rudimentary antheridium of *Asplenium alatum*. Only the lower ring cell is cut off. Its cell-nucleus lay to the left, and was distinct when the antheridium was generally in focus.

Fig. 12. Like the last.

Fig. 13. Somewhat later developmental state. The upper cell has divided into a shallow bell-shaped outer cell and the central cell: *a* & *b* as under fig. 2.

Fig. 14. The bell-shaped cell has already been divided into the second ring cell and the opercular cell; the central cell is still undivided. (After treatment with caustic potash and muriatic acid.)

Fig. 15. A somewhat older stage. The central cell is already divided into eight cells, of which only four are visible. (Treatment as under fig. 14.)

Fig. 16. Mature antheridium with three ring cells; the intermediate ring cell is set obliquely upon the inferior one, so that one side of the latter is excluded from the envelope of the special mother cells.

Fig. 17. Evacuated antheridium, with three ring cells, in each of which a spherical nucleus is distinctly visible.

Fig. 18. Young antheridium of *Cibotium Schidei*, seen from above. The central cell is broken up into four quadrants, of which two are already again divided; the operculum consists of two cells. (After treatment with caustic potash and muriatic acid.)

Fig. 19. Young antheridium, seen from the side. The central cell is still undivided. By a mistake of the lithographer, the circle in which the lower funnel-shaped septum applies itself to the outer wall is placed rather too low down.

All the figures are drawn with the camera, and magnified 325 diameters.

XXV.—*On Additions to the Coleopterous Fauna of the Cape-Verde Islands.* By T. Vernon Wollaston, M.A., F.L.S.

Fam. **Hydrophilidæ**.

Genus Philhydrus (Col. Hesp. p. 44).

My attention has lately been drawn by Dr. Sharp (who has studied the *Philhydri* with considerable care) to the fact that what I had hitherto regarded (on the authority, originally, of Aubé) as the *melanocephalus* of Olivier is *not* referable, in reality, to that insect. Moreover the *Cape-Verde* examples appear, in addition, to be separable into *two* species, both of which are distinct from the one (recorded by myself, equally, as the "*melanocephalus*") which is so universal in the Madeiran and Canarian archipelagos, and which Dr. Sharp is of opinion should be identified with the Mediterranean *P. politus* of Küster. These two Cape-Verde *Philhydri* he considered to be undescribed; and he has lately, therefore, at my own request, published diagnoses of them, which, however, much they may be related *inter se*, establish at all events the fact of